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Heritable risk sensitive foraging in juvenile fish: Potential implications for the dynamics of harvested populations.

Walters and Juanes (1993) proposed that heritable risk sensitive foraging behavior in juvenile fish could cause substantial delays in the recovery of a population if selection has favored individuals with reduced foraging times while population abundance is low. They predict that such selection may occur in an over-exploited stock given the following conditions i.) spawning stock abundance has been eroded to a point where there is a reduction in juvenile density, ii.) reduction in juvenile density reduces competition between juveniles, iii.) predation risk forces juveniles to forage in small volumes near predation refuges, iv.) food availability in these small volumes is affected by juvenile density, v.) juvenile density remains low long enough for selection to occur. Low juvenile density could favor individuals with reduced foraging times, due to improved survival resulting from less exposure to predation risk, while high juvenile density could favor extended foraging time, in spite of predation risk, due to relatively better growth resulting from increased consumption during foraging bouts. If juvenile density remains low long enough for selection to occur, the proportion of individuals with reduced foraging time as juveniles will increase. When harvesting is halted, allowing spawning and juvenile densities to increase, there may be a substantial delay in stock recovery as a result of poor survival in the juvenile stage due to a predominance of individuals with reduced foraging time.

I attempted to select for reduced and extended foraging time in populations of guppies (*Poecilia reticulata*) by maintaining high (non-harvested) and low (harvested) density adult populations over a number of generations. These populations were then reduced to the same abundance and the resulting population recoveries were monitored. Although there appeared to be a decrease in the amount of time juveniles spent foraging in low density populations, changes could not be attributed to selection for reduced foraging time. The observed reduction in juvenile foraging time during the experiment was attributed to a substantial increase in predation risk caused by cannibalism from large adult females. When the populations were reduced to the same abundance after the selection experiment, one low density population recovered more slowly and to a lower abundance than the high density population. The low equilibrium abundance observed in takes that were held at low density was attributed to a substantial reduction in juvenile survival as a result of cannibalism.

Heritable, risk-sensitive foraging was incorporated into an age-structured genetic model of the northern cod fishery to see if selection for individuals with reduced foraging time could explain the observed decline in mean weight-at-age in the catch as well as the impact that such selection would have on the recovery of the northern cod population after the 1992 fishery closure. A genetic model containing heritable differences in juvenile foraging behavior reproduced the observed trend in mean weight-at-age in the catch. When the recovery time of the genetic model was compared to a model where all juveniles had the same average foraging behavior, the genetic model population recovered to a pre-1962 abundance faster. However, the resulting stock was less

productive and composed of smaller individuals than the historical pre-1962 stock. Stock productivity and size structure did not return to pre-1962 levels until the genetic composition of the stock recovered. Genetic composition of the simulated stock did not receiver to pre-1962 levels until approximately 200 simulated years after the fishery closure.